HOME PERFORMANCE
STAKEHOLDER COUNCIL

Heat Pump Best Practices Installation Guide for Existing Homes

Agenda

- Section 1: Introduction
- Section 2: Overview of Guide
- Section 3: Heat Pump Basics
- Section 4: Overview of Best Practices
- Section 5: Conclusions and Q&A
- Section 6: Rebates for Heat Pump Installations

Section 1: Introduction

THIS SECTION WILL INTRODUCE THE PRESENTERS AND THE GUIDE, AND DISCUSS THE BENEFITS OF HIGH-QUALITY INSTALLATIONS AND POTENTIAL CONSEQUENCES OF A POOR JOB

Organizer

- Home Performance Stakeholder Council (HPSC)
  - Not-for-profit society that represents residential sector interests related to energy-efficiency and conservation
  - Helping the home performance industry develop and grow into a sustainable and profitable market segment that delivers products and services to:
    - **Lower** utility bills through reducing energy use
    - **Improve** home comfort and building durability
    - **Reduce** environmental impact
    - **Improve** air quality, health and safety

Partners

- Heat Pump Guide funded by:
  - FortisBC
  - BC Hydro
  - Government of British Columbia
  - City of Vancouver

Presenters

- **Rob George, Residential HVAC Expert, ICF – TECHNICAL EXPERT**
  - 56 years' experience in the HVAC industry
  - Designed, fabricated, installed and serviced residential and commercial HVAC systems
  - Last 20 years focused on developing and delivering technical training programs for HVAC industry professionals

- **Jordan Fisher, Mech Retrofit EE Consultant, FRESCo – LOCAL EXPERT**
  - Energy efficiency consultant with a specific focus on mechanical retrofits
  - Supporting the improvement of residential HVAC installations in BC
  - Led development of the Installation Quality Guidelines for the FortisBC/BC Hydro Program Registered Contractors (PRC) initiative
  - Delivered in-person and online training to over 100 residential heat pump installers across BC

Presenters (cont'd…)

- **John Dikeos, P.Eng., Senior EE Consultant, ICF - MODERATOR**
  - Energy efficiency consultant with over 12 years of experience
  - Work has focused on assessments of energy efficiency technologies, energy efficiency potential studies, DSM program design, and the implementation of innovative energy efficiency programs

Webinar Logistics

- Interactive components (polls) included throughout the course
- Please submit any questions via chat window
  - Questions to be addressed during Q&A session near the end of the presentation
- Groups of participants under one registrant
- Opportunity to provide feedback on the webinar at the end of the session

Disclaimers

- Target audience:
  - Guide and Webinar targeted at Heat Pump Installers having significant experience in this field
  - This includes knowledge of:
    - Heat loss and heat gain calculations
    - Airflow/duct design
    - How to measure, test, and commission home comfort systems
    - Relevant codes and standards in BC

Disclaimers (cont'd…)

- General disclaimers:
  - Although proper care has been taken to confirm the accuracy of the information contained in the Guide and this Webinar, the authors, advisory group members, other contributors, funding partners, and publishers assume no liability for any loss, damage, or injury that may be incurred or suffered as a result of any type of use or reliance on the contents and recommendations of this Guide
  - Guide and Webinar are not a substitute for proper training and relevant experience related to residential heat pump system design, installation, commissioning, and maintenance

Purpose of Guide

- BC-specific best practice installation to support BC installers/contractors on the quality installation of air-source heat pumps in residential retrofit applications
- Main objective is to shift the marketplace towards best practices
- CleanBC Better Homes and BC Hydro/FortisBC Home Renovation Rebate programs may reference this Guide in the terms and conditions for Program Registered Contractors (PRC) in the near future

Guide Development Process

- Prepared by ICF, with support from FRESCo
- Leveraged the following sources:
  - Leveraged existing relevant best practices documents, ASHP installation guides, and related training material
  - Related codes and standards
  - Input from with subject matter experts, including experienced installers in BC, to address gaps and ensure that local context is well-represented
- Developed in consultation with an Advisory Group consisting of individuals and organizations involved in the residential HVAC industry.
  - Advisory Group provided detailed feedback on draft versions of the Guide

Poor Design and Installation of ASHP Systems

- Various studies have found significant reductions in the overall efficiency of heat pump systems as a result of design and installation issues
  - US Department of Energy (DOE) estimates that the majority of HVAC systems do not perform at their rated efficiency as a result of improper installation
- A recent study on ASHP installation practices in BC indicated that only 32% of the studied ASHP installations were well-matched with the heating requirement of the homes they were installed in
  - Study showed that the poorly installed single stage ducted systems were using about the same amount of energy as an electric furnace (i.e. the heat pump was barely operating at all)

Benefits of Quality Installation

Contractor Benefits	*Homeowner Benefits*	*Societal Benefits*
Improved client satisfaction, leading to more referrals and fewer callbacks	More comfortable indoor environment (e.g. fewer cold spots, more consistent temperature distribution, etc.)	Improved province-wide uptake of heat pump systems
Differentiation between high quality and poor, lower cost and quality installations	Increased economic life of ASHP system and reduced maintenance issues	More efficient use of BC's green electricity grid
Compliance with future codes, regulations, and permits	Improved utility bill savings	Important component to achieve BC's climate change goals

Risks of Poor Installation

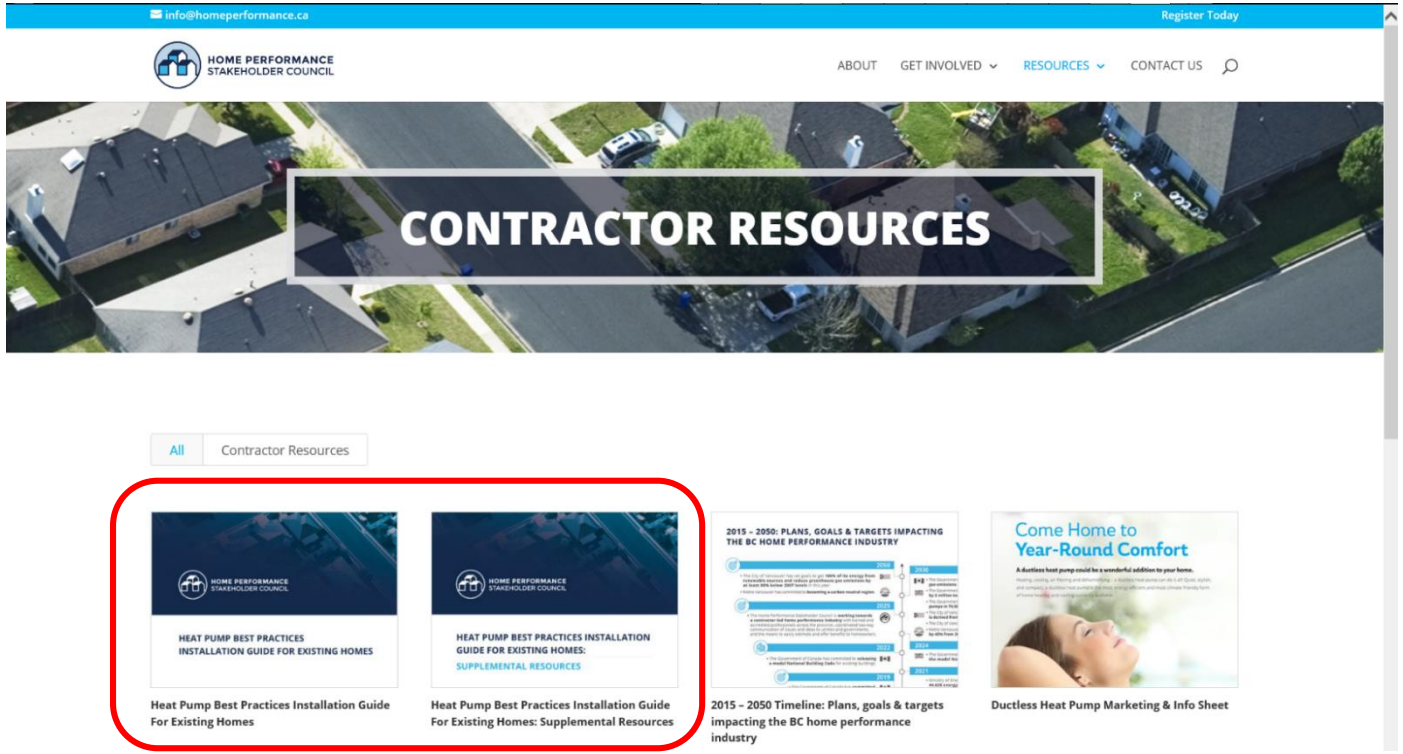
Contractor Risks	Homeowner Risks	Societal Risks
Customers dissatisfaction and more callbacks	Uncomfortable indoor environment (e.g. cold spots, uneven temperature distribution, etc.)	Reduction in province-wide uptake of heat pump systems
Reputational risk and loss of future business	Wasted energy consumption and associated higher costs	Inefficient use of BC's electricity grid
Bad reputation and may not be allowed to participate in available rebate programs	Decrease in useful life of the heat pump, health/safety risks, and/or potential void to warranty	Jeopardize achievement of BC's climate change goals

Section 2: Overview of Guide

THIS SECTION WILL GIVE AN OVERVIEW OF CONTENTS OF THE HEAT PUMP BEST PRACTICE INSTALLATION GUIDE AND SUPPLEMENTARY RESOURCES DOCUMENT

Access Documents

- Heat Pump Best Practices Guide and Supplemental Resource document:
  - HPSC website: http://homeperformance.ca/contractor-resources/
  - CleanBC Better Homes website: https://betterhomesbc.ca/contractor-support/



Guide Layout and Contents

Three (3) main sections:

1. **Heat Pump Basics:** Importance of Good Design and Installation, Types of Heat Pumps, Heat Pump System Comparison, and Relevant Code References
2. **Homeowner Education:** Why Choose a Heat Pump, Steps to a High-Quality Installation, System Selection Reference Guide, and Identifying Quality Installations
3. **Contractor Section:** House as a System; Steps to a High-Quality Installation; Job-Site Survey and Pre-Changeout; System Design (Sizing and Selection); Installation; Equipment Commissioning; Homeowner Education and Maintenance; and Common Challenges and Solutions

- Guide also includes Glossary, Additional Resources, and References

Helpful Resources

- Pros and cons of different ASHP systems (Section 1.4)
- System selection reference guide (Section 2.3)
- Identifying quality installations (Section 2.4)
- Steps to a high-quality installation (Section 3.2)
- Job-site survey checklist (Exhibit 12, Section 3.3)
- Sizing of ASHP and supplementary heating systems (Exhibit 15, Section 3.4)
- Common challenges and solutions (Section 3.7)

Supplemental Resources

- Separate document with useful resources from guide, plus additional documents

Two (2) main sections:

1. **Heat Pump Reference Guide for Homeowners:** Modified version from Guide, shareable with homeowners
2. **Contractor Resources:** Helpful resources from Guide and supplemental resources (i.e. Sample Quotation, Sample Best Practice Installation Checklists, Sample Heat Pump System Commissioning Report)

Section 3: Heat Pump Basics

THIS SECTION WILL DISCUSS BASICS OF HEAT PUMP INCLUDING DIFFERENT TYPES OF HEAT PUMP, STANDARD AND PERFORMANCE.

Heat Pumps

- Extracts heat from one location and transfer it to another location
- Two common types of heat pumps used for space heating in low-rise residential applications:
  - Air-source heat pumps (ASHPs)
  - Ground-source heat pumps (GSHPs)
- ASHPs are the most common type of heat pump currently installed in Canadian homes
  - Focus of Guide

Types of Air-Source Heat Pumps

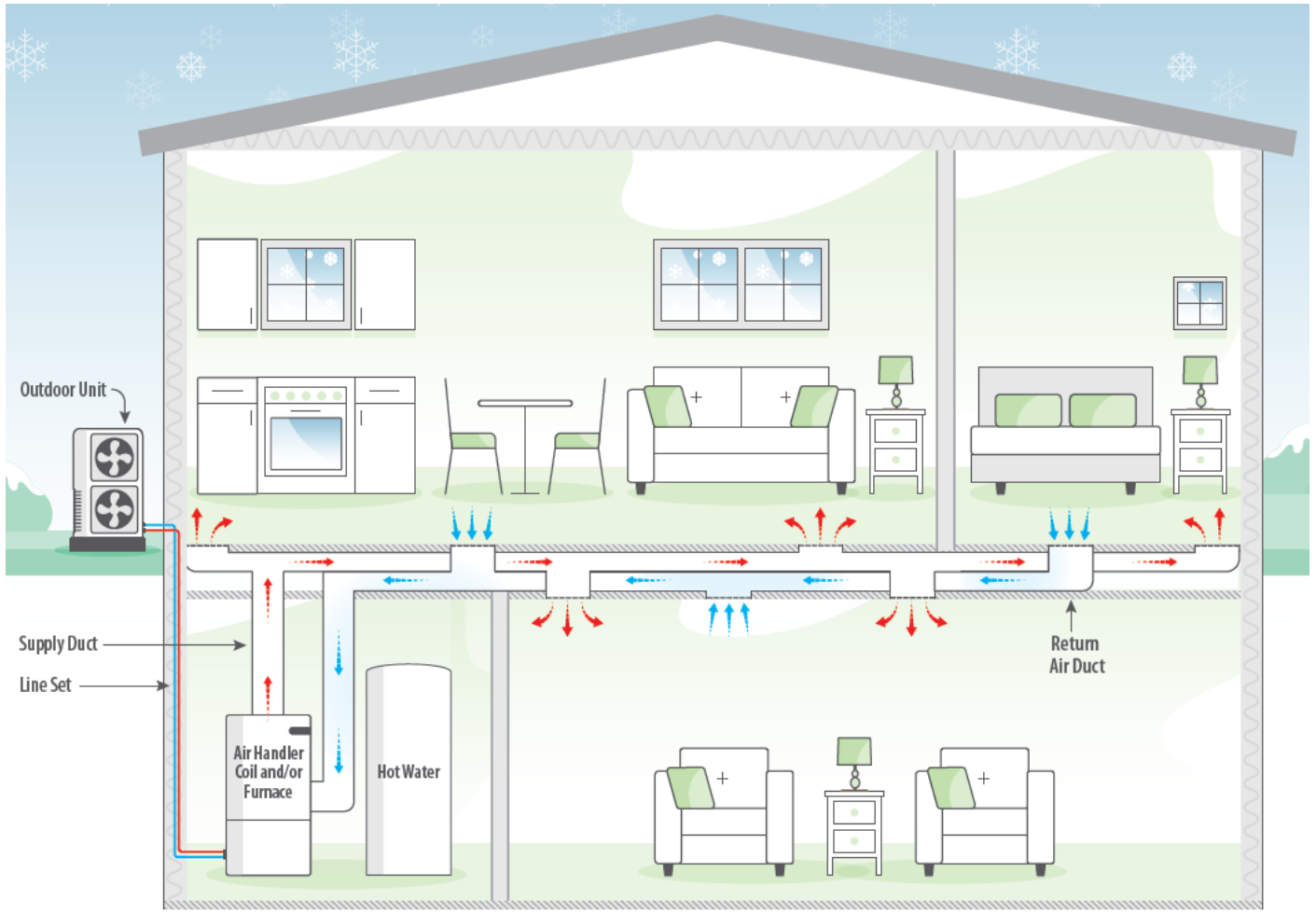
- Types of air-source heat pumps (ASHPs):
  - Centrally Ducted
  - Mini-Split (Single zone or multi-zone)
    - Ductless
    - Mini-Ducted
- Conventional and cold climate variants
  - **Conventional ASHPs:** Operate in heat pump mode with outdoor temperatures as low as -8°C to -12°C
    - Lower heating capacity at colder temperatures
  - **Cold Climate ASHPs:** Operate in heat pump mode with outdoor temperatures as low as -25°C
    - Better performance at lower temperatures
    - Basic units incorporate a larger compressor and a larger outdoor unit
    - More advanced (and expensive) units can operate at colder temperatures.

Centrally-ducted

Ductless

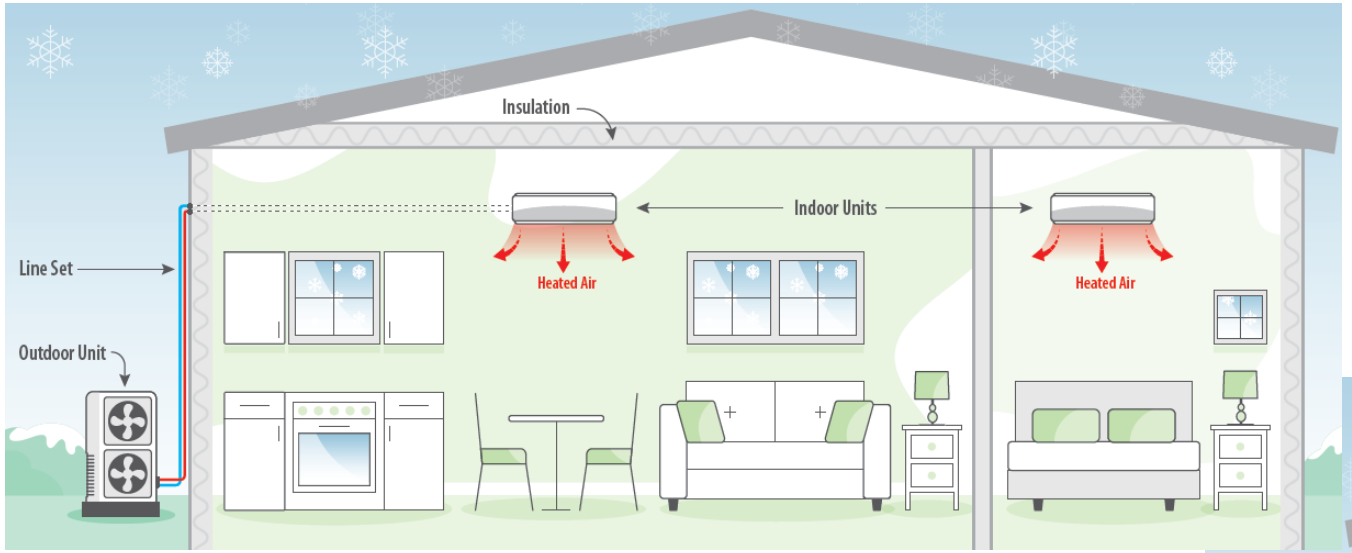
Mini-ducted

ASHP System Layouts



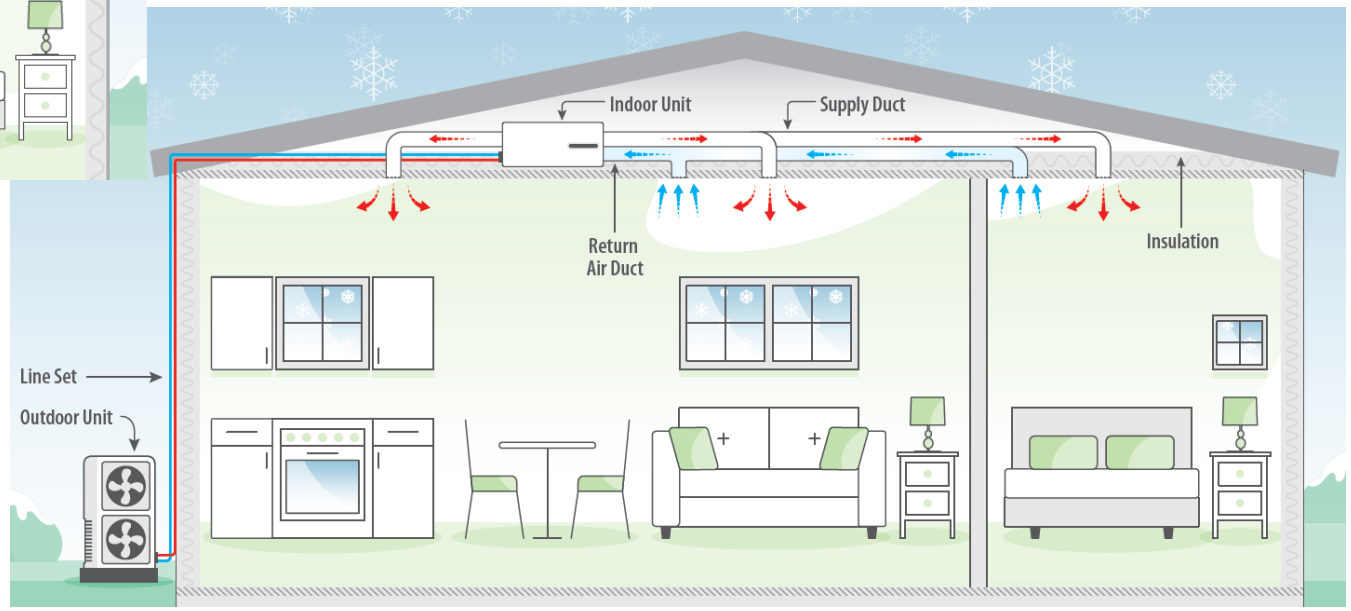
Centrally Ducted System

ASHP System Layouts (cont'd…)



Ductless System

Mini-Ducted System

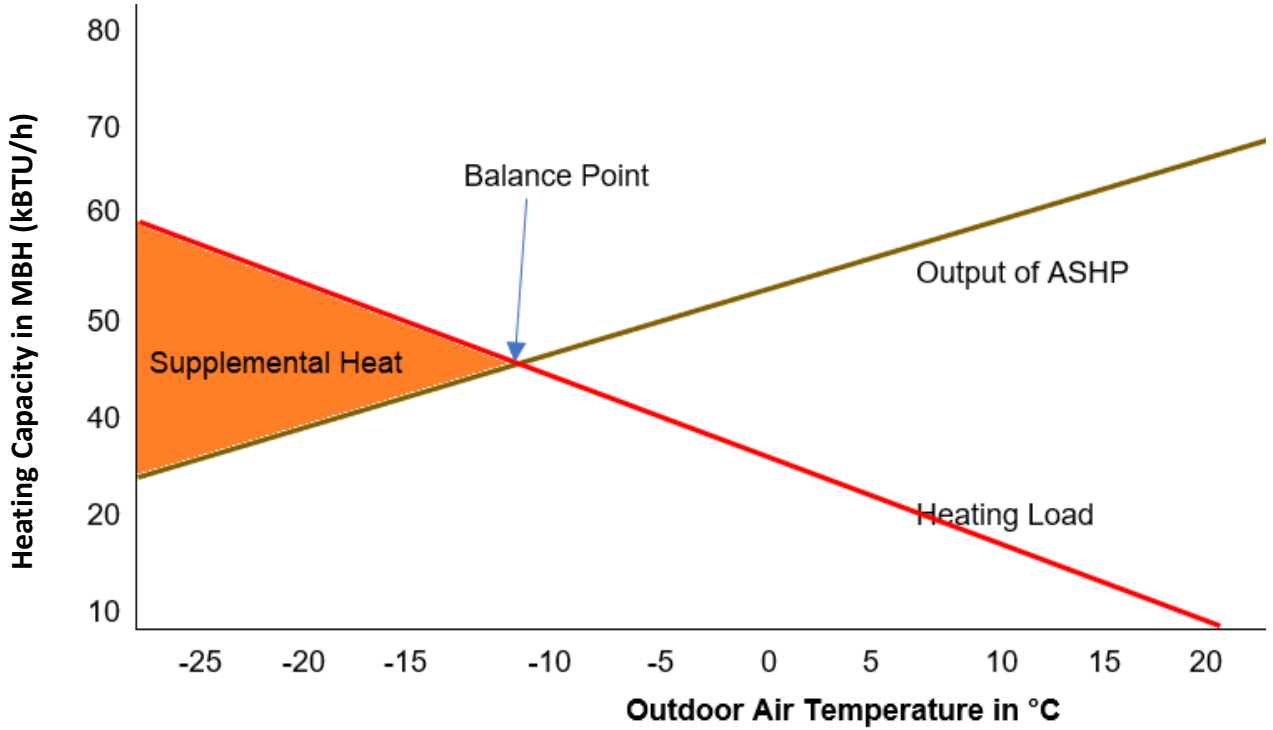


ASHP System Comparison

	Centrally Ducted ASHPs	Ductless ASHPs	Mini-Ducted ASHPs
PROS	+ Effective solution for homes with central ducting + Indoor units can be smaller than many conventional furnaces + Far more energy-efficient and cost-effective than oil or electric resistance heat	+ Easy and quick installation by qualified professionals + Require no ductwork + Cost-effective method to heat individual rooms or zones that are routinely occupied + Using multiple ductless systems improves HVAC system reliability	+ Concealed equipment improves visual appeal + Quieter operation than other ASHP systems + Can be a cheaper alternative to multi-head ductless ASHPs + Effective solution for rooms with smaller heat loads
CONS	- Upgrading of electrical connection may be required to accommodate new system - Existing ducting in older homes may need to be improved/upgraded	- Each indoor unit serves a single zone or room rather than the entire home - Indoor wall units take more space and may look bulky to some	- Lower efficiency than ductless ASHPs - Installation of ducting is challenging in some existing homes
IDEAL FOR	Larger homes with central heating and cooling (forced air system) having existing ductwork in good condition	Small or large homes with baseboard heating and no ductwork	Small or large homes with baseboard heating, no ductwork, and easy access to install ducting

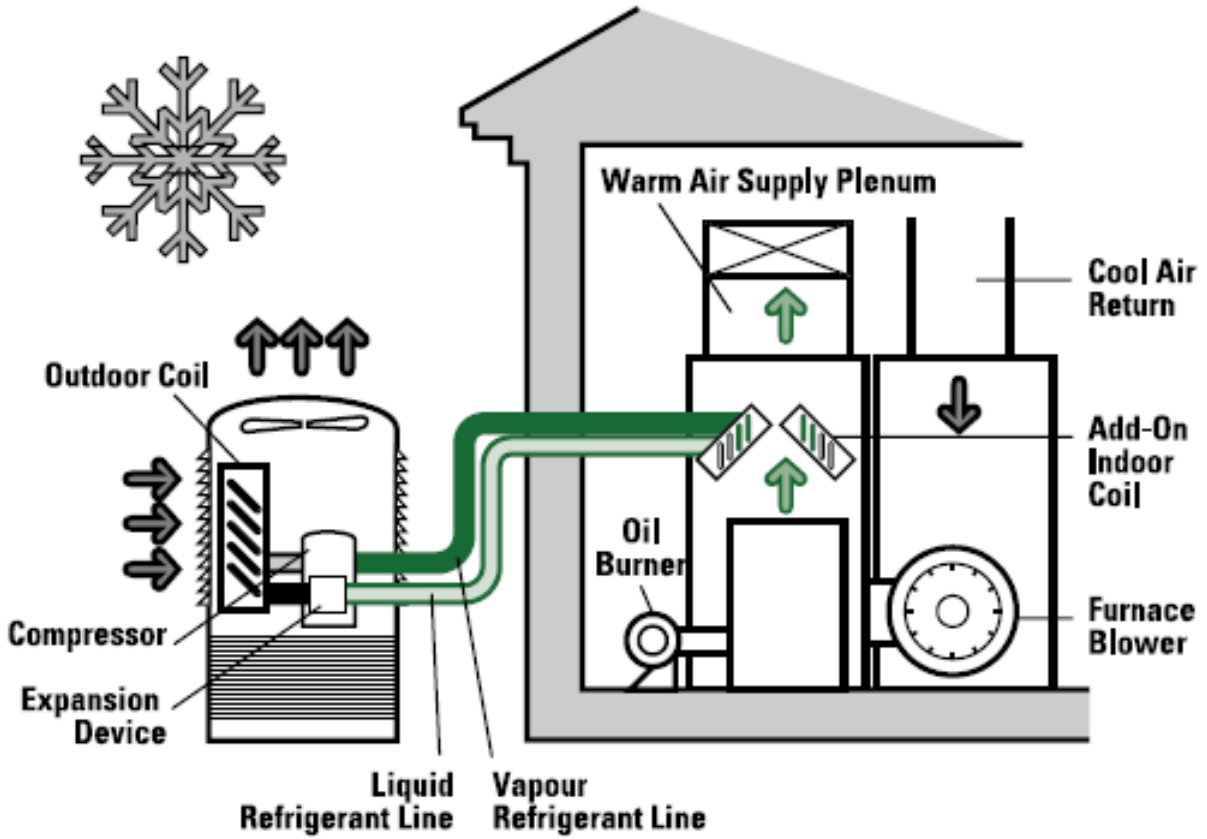
Supplementary Heating

- Heat pump output drops with colder outdoor temperatures
- Where applicable, supplementary heating is used at colder temperatures (i.e. beyond thermal balance point)
- Also sometimes used during defrost cycles
- Two configurations:
  - Integrated with the heat pump system (e.g. electric resistance coil)
  - Supplemental heat (e.g. electric baseboards or fossil fuel furnace)
- Where it's easily achieved, can be sized for emergency (backup) heating



Dual Fuel Systems

- Existing fossil fuel system can be used as supplementary heating system
- Existing system generally sized to meet entire space heating load
- May be an economic benefit to using existing system during colder weather, when heat pump is less efficient
- Electric grid benefits since there is reduced demand on the coldest days of the year



Dual-Fuel Air-Source Heat Pump in Heating Mode

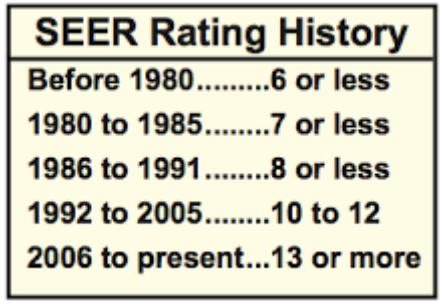
ASHP Performance

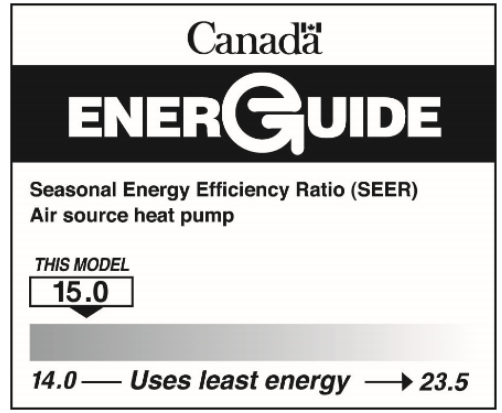
HEATING:

- **HSPF:** Heating Seasonal Performance Factor
  - BTUs of heating output per watt-hours of energy consumed
- **COP:** Coefficient of Performance
  - Heating output per unit of energy consumed

COOLING:

- **EER:** Energy Efficiency Ratio
  - BTUs of cooling per watt of electrical power
  - Efficiency of cooling equipment at test conditions
- **SEER:** Seasonal Energy Efficiency Ratio
  - Annual BTUs of cooling divided by annual electrical power input
  - Accounts for part-load performance throughout year

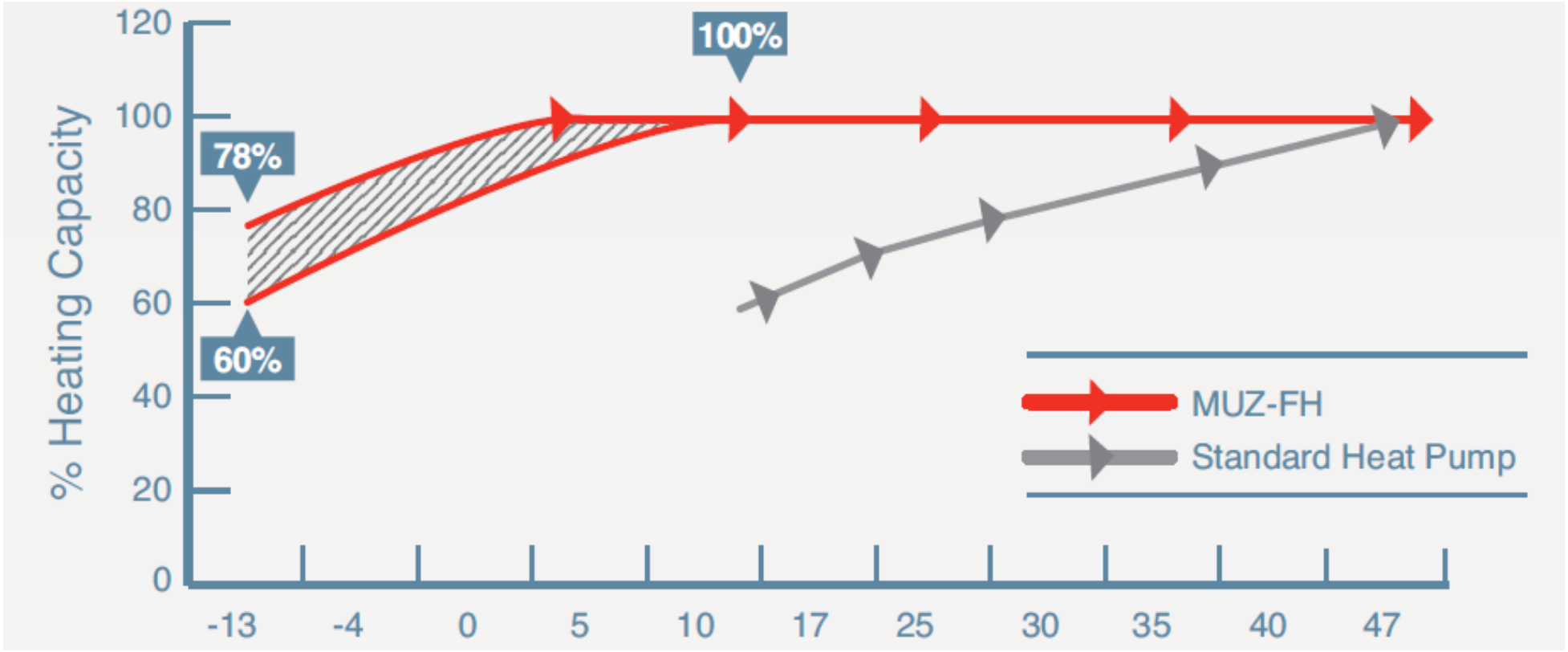




Source: Natural Resources Canada

Equipment Type	Min Standard in BC
Heating:	
Centrally Ducted ASHPs, Ductless ASHP, and Mini-Ducted ASHPs	Starting in 2020: HSPF V ≥7.39 (HSPF IV ≥8.5)
Cooling:	
Split System – Ductless, Mini-ducted and Centrally Ducted	SEER = 14.5 EER = 11.5
Single Package System	SEER = 14 EER = 11

Cold Climate ASHP Performance



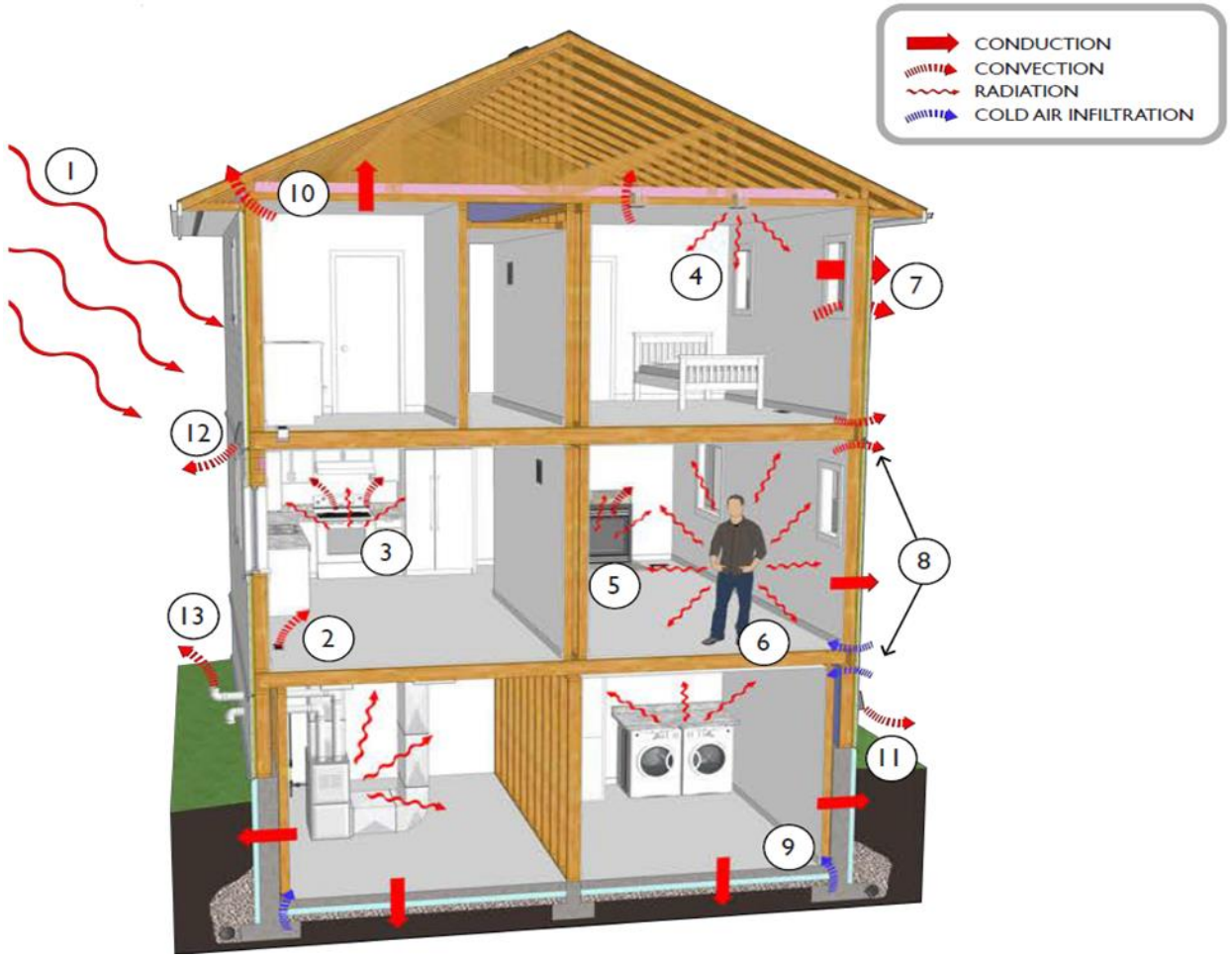
Source: https://www.mitsubishipro.com/pdfs/m-series-catalog.pdf

Section 4: Overview of Best Practices

THIS SECTION WILL DISCUSS THE ASHP BEST PRACTICE INSTALLATION CONSIDERING HOUSE AS A SYSTEM

House as a System

1. Solar radiation
2. Space heating
3. Appliances
4. Lighting
5. Fireplaces
6. Occupants
7. Windows and doors
8. Walls
9. Basement
10. Attic
11. Dryer ducts
12. Exhaust fans (ventilation system)
13. Combustion appliance flues



Steps to a High-Quality Installation

Step 1: Job-Site Survey and Pre-Changeout

- Initial assessment of the existing heating and cooling system, ducting system, and occupancy.

Step 2: Design (Sizing and Selection)

- Calculating heating and cooling loads: CSA standard CAN/CSA-F280
- Sizing of equipment: CSA standard CAN/CSA-C273.5-11

Step 3: Installation

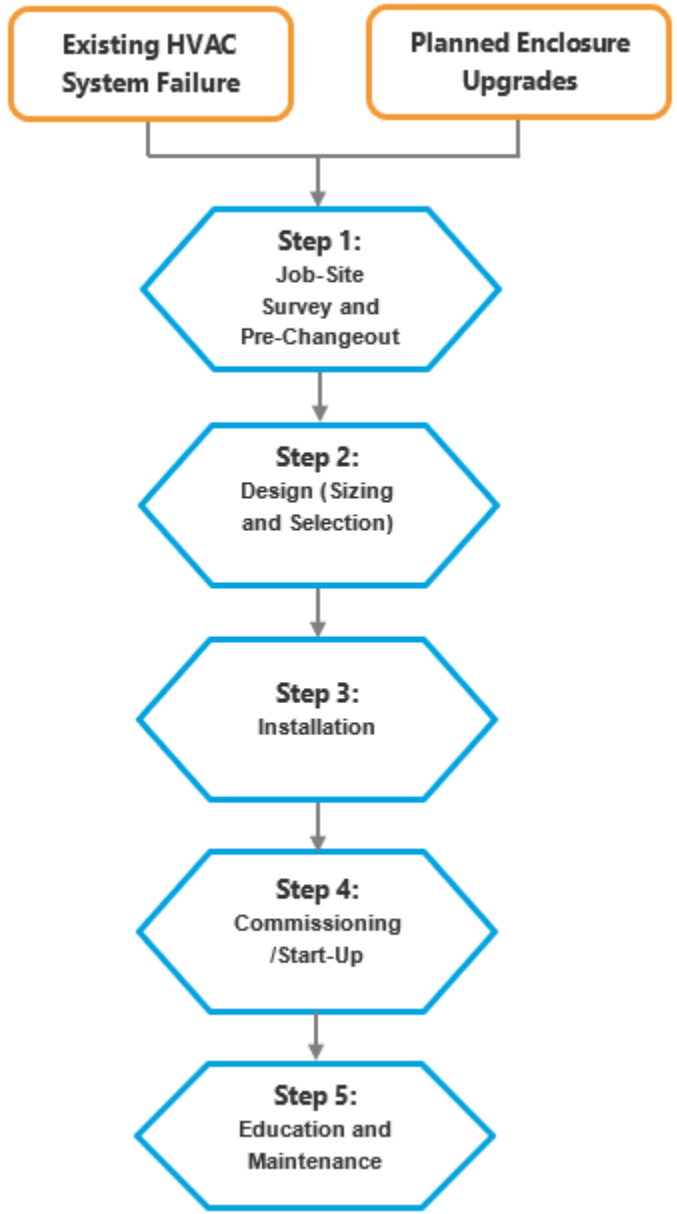
- Should meet CSA standard CAN/CSA-C273.5-11 and all other required codes and standards.

Step 4: Commissioning/Start-Up

- Tests to ensure the system is operating properly.

Step 5: Education and Maintenance

- Educate homeowners about operation and maintenance procedures.



Job-Site Survey and Pre-Changeout

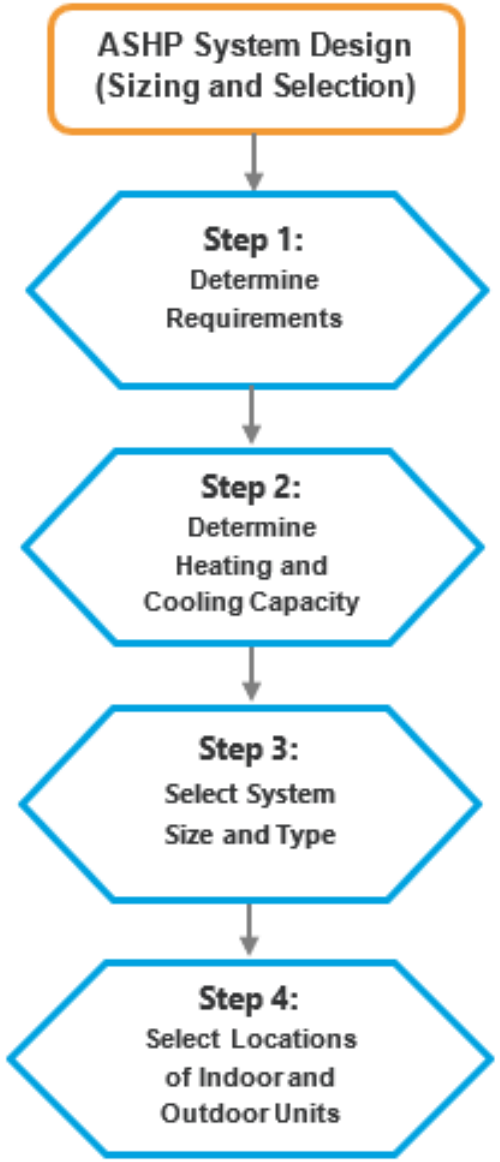
- Interview homeowners
  - Homeowner's expectations, concerns, and needs
  - Planned and/or recent home retrofits
- Evaluate existing HVAC systems
  - Type of system (space, central, split, package, etc.)
  - Ventilation system layout
- Evaluate building enclosure
  - Exposed above grade walls and basement walls
  - Ceilings, roof, windows, doors, and skylights
  - Foundation type and insulation
- Gather other site information
  - Relevant plans, sketches, and notes
  - Architectural and space constraints

JOB-SITE SURVEY CHECKLIST

Item	Description	Orientation			
		North	South	East	West
Homeowner's Requirements					
Homeowner's requirements and reason for replacement	Mainly for heating or cooling				
Indoor unit preference*	Homeowner preference for floor-mounted, high wall-mounted, or ceiling-mounted unit				
Control type preference	Wi-Fi enabled remote control or other				
Location and Home Type					
Outdoor design conditions					
Indoor design conditions					
Home Type	Vintage, single detached, middle-unit townhome, etc.				
Zoning requirements					
Room types	Typical single room or a large or open plan room/hallway, where more than one unit may be required				
Plans, Sketches, Notes					
Measurement, Areas, and Volumes					
Windows					
Doors					
Exposed walls					
Above grade walls					
Partitions					
Daylight-basement floors (wedgies)					
Closets (size matters)					
Halls (size matters)					
Above grade volume (for infiltration)					

System Design (Sizing and Selection)

- Determine requirements
  - Heating (or heating and cooling) displacement
  - Full HVAC system replacement
  - Isolated zone
- Determine heating and cooling capacity
  - Foundation of the system design procedure
  - CSA Standard F280-12 (Right-F280™, TECA Quality First™ Heat Loss & Heat Gain)
  - Use ‘smallest defensible load’ approach to optimize system performance and customer satisfaction



System Design (Sizing and Selection) (cont'd...)

- Section 5 of CAN/CSA standard C273.5-11
- The minimum capacity of the selected system (i.e. ability to modulate) is as important as the maximum capacity.
- When installing multi-zone systems, consider using separate single-zone systems or increasing the number of outdoor units, each with lower capacity and with fewer zones.
- The heating capacity of heat pumps declines with lower outdoor temperatures.
  - Proposed ASHP system must be able to provide the required heating at the outdoor design temperature where the system is being installed.

Sizing of ASHP and Supplementary Heating System

- In cooling and partial heating scenarios (rare in BC), size to 100-125% of design cooling load
- In other cases, size heat pumps using calculated heating load
- In warmer regions, use conventional heat pumps
  - No supplementary heating necessary (in addition to defrost) but can use existing heating system as backup
  - In case of duct constraints, use cold-climate units or supplemental electric coil
- In colder regions, use cold climate heat pumps
  - Heating down to -25°C
  - Supplemental heating to be employed where necessary

Sizing & Selection Example

Calculated heating load: 14,000 BTU/h (4.1 kW)

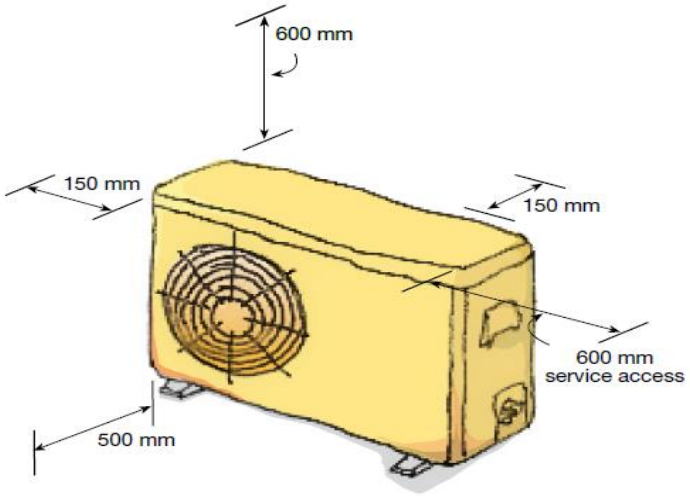
Outdoor design temperature: -11°C

Nearest temperature below design temp: -15°C

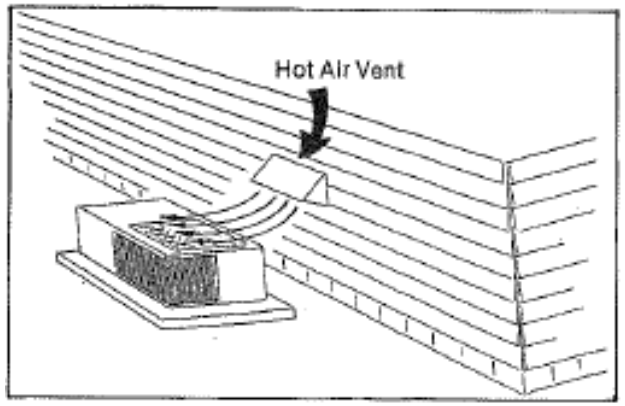
Model A: Capacity (kBTU/h), 12,000 BTU/h Rated Output															
Indoor Temp	Outdoor Temperature														
20°C	-15°C (5°F)			-8.3°C (17°F)			0°C (32°F)			1.7°C (35°F)			8.3°C (47°F)		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	7.2	2.31	3.12	8.64	2.73	3.15	11.1	3.3	3.31	11.4	3.36	3.4	12.3	3.54	3.5
Model B: Capacity (kBTU/h), 18,000 BTU/h Rated Output															
Indoor Temp	Outdoor Temperature														
20°C	-15°C (5°F)			-8.3°C (17°F)			0°C (32°F)			1.7°C (35°F)			8.3°C (47°F)		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	10.8	3.9	2.76	12.96	4.62	2.8	15.3	5.13	2.98	15.6	5.25	3.0	18.3	5.7	3.2
Model C: Capacity (kBTU/h), 24,000 BTU/h Rated Output															
Indoor Temp	Outdoor Temperature														
20°C	-15°C (5°F)			-8.3°C (17°F)			0°C (32°F)			1.7°C (35°F)			8.3°C (47°F)		
	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP	Output	Input	COP
	14.4	5.55	2.59	16.95	6.15	2.75	18.6	6.75	2.8	19.2	7.2	2.7	24.3	7.8	3.1

Location of Outdoor Units

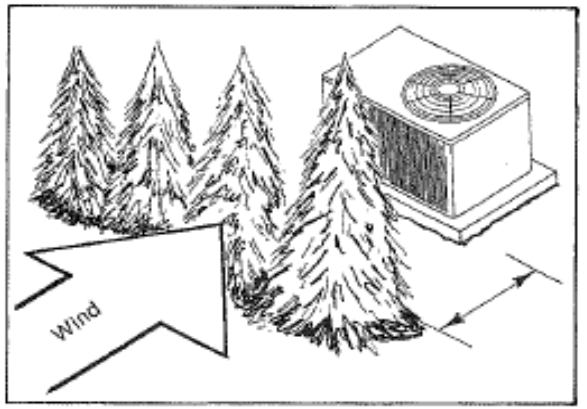
- Away from fences, walls, and other surfaces to allow unimpeded air flow around the unit
- Maintain minimum distances from obstructions as recommended in OEM
- Keep refrigerant pipe run lengths and bends at minimum level
- Protected from the sea spray in coastal areas and sheltered from frost and strong winds.
- At a safe distance from any gas sources or appliances



Source: EECA, New Zealand



Source: ACCA Manual H



Source: ACCA Manual H

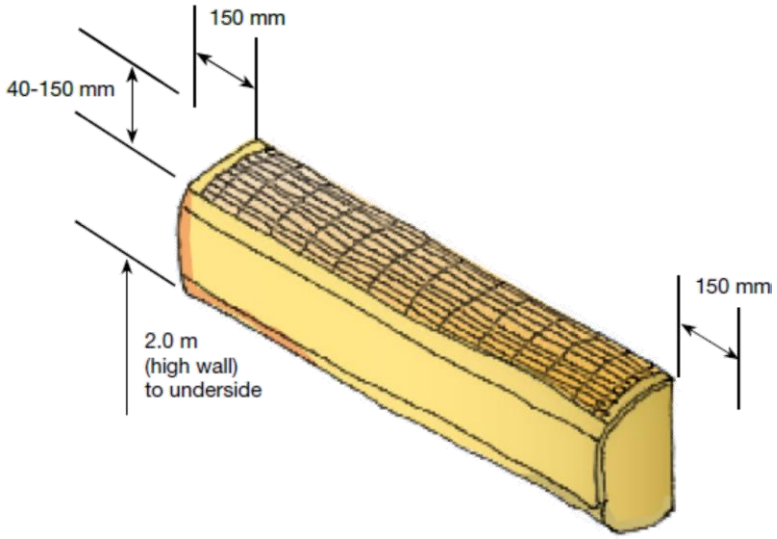
Location of Outdoor Units (cont'd…)

DO NOT LOCATE:

- Where operating noise may disturb home occupants or neighbors
- In any location that may impede airflow
  - For instance, there may not be enough airflow under the house or deck
- Below a window where the unit has a vertical discharge
- So that multiple outdoor units are competing for airflow
- Where people pass (i.e. close to an accessway or path) since freezing discharge can pose a slip hazard
- On a balcony or deck that is more than 1 m above a surface below in a way that facilitates climbing over any nearby railings.

Location of Indoor Units

- Maintain minimum distances from obstructions as recommended in OEM
- Adequate clearances for making all connections and servicing
- A clear airflow path is maintained
- Minimize refrigerant pipe run lengths and bends
- The condensate drainage piping can drain to outside without the need for a condensate pump



Source: EECA, New Zealand

Location of Indoor Units (cont'd…)

DO NOT LOCATE:

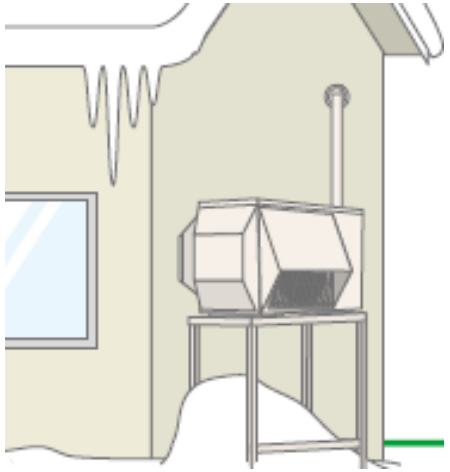
- In a tight corner or space
- Behind a grille
- So that they direct air to a primary source of heat gain or loss, such as windows
- Where there may be any steam
- Within a kitchen or near an automatic insect repellent dispenser
- Above or close to any heat source, including electrical appliances, which could affect the performance or act as an ignition point

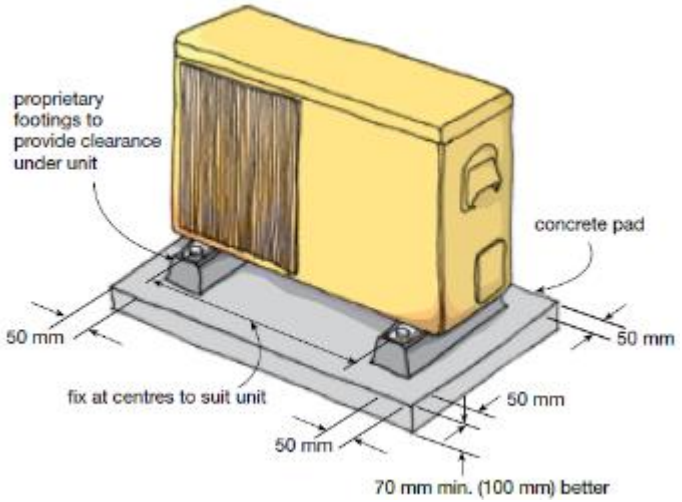
High-Level Steps to a Quality Installation

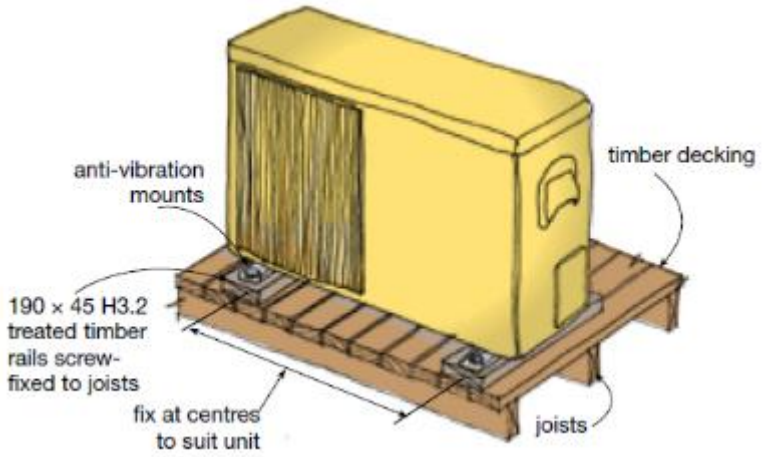
- Perform an F280 compliant load calculation to ensure the proper capacity system is selected.
- Evaluate the mechanical room layout/spacing and existing equipment to ensure availability of sufficient space for selected retrofit equipment
- Ensure that the duct system can handle system airflow requirements by evaluating the existing duct system and comparing it to the required capacity
- Follow equipment manufacturer's installation guidelines
- Ensure that all related local codes and standards have been meet
- Ensure that all health and safety considerations are addressed.

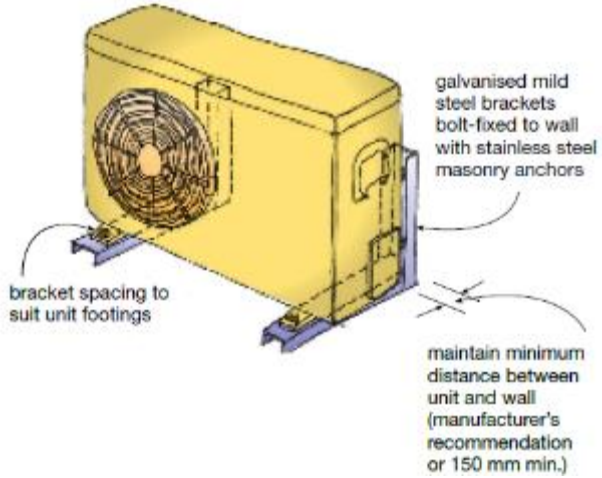
Installing Outdoor Units

- Should be level,* both side-to-side and front-to-back and cannot fall over
- Their weight is fully supported to prevent sagging
- Units create no vibration; in cases where vibration is unavoidable, anti-vibration mounts should be used
- Use wall brackets designed for attachment to foundation wall, where ground clearance allows









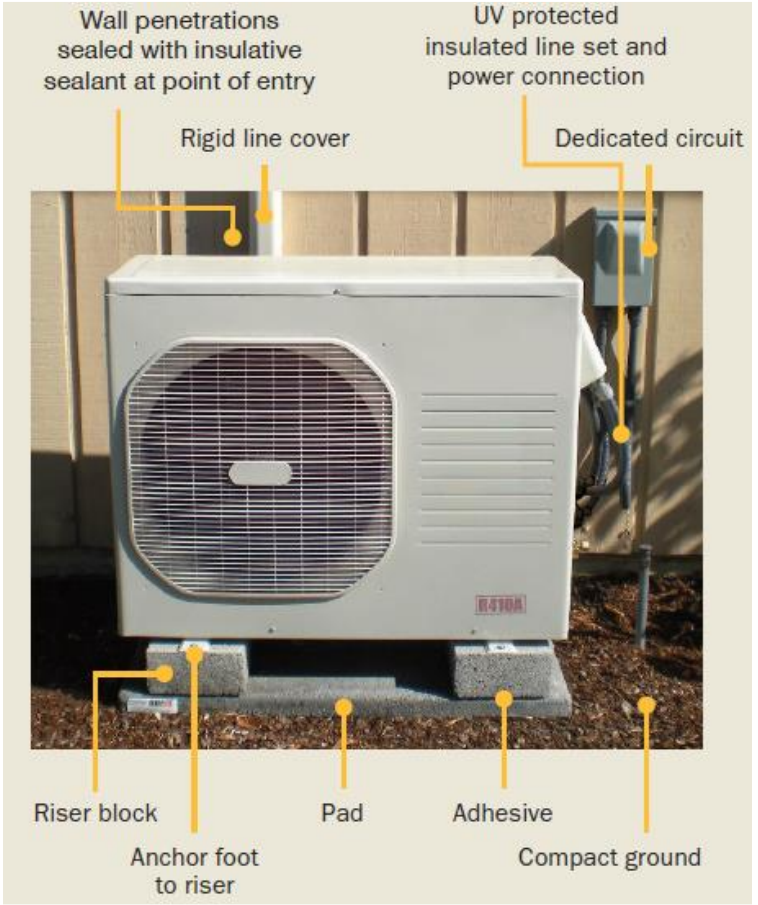
Identifying Quality Installations: Outdoor Units

POOR INSTALLATION

Soil and Footing

Ground clearance

BEST PRACTICE



Installing Indoor Units (Ductless)

- Install wall mounted indoor units with adequate clearance from the ceiling for making all connections, for servicing the unit, and for replacing the components contained.
- Ensure that the wall is structurally strong enough to carry the load of the unit
- Ensure that wall space where the unit is being installed is free from electrical cables, plumbing and cross bracings
- Ensure that the unit is securely seated
- If space allows, install floor-mounted units in larger living areas and lower levels of 2-story homes

Clearance from ceiling and easy access for maintenance

Identifying Quality Installations: Line Set & Penetrations

POOR INSTALLATION

Line set insulation

BEST PRACTICE

Sealing penetrations

Refrigerant Line Set and Tubing (cont'd...)

DO NOT:

- Reuse manufacturer provided tubing flares and fittings
- Use an old R22 flaring tool for R410A refrigerant systems (i.e. R410A flaring tools create a larger flare wall to withstand the higher refrigerant pressures of R410A systems)
- Use line sets used for R22 for R410A systems without flushing them with an agent like RX11
- Use a saw blade to cut the pipe
- Mix polyolester oil and mineral-based oil
- Use leak lock or PTFE tape, as these are not plumbing joints
- Cross thread the fittings, as you may damage them

Refrigerant Charge and Adjustment

- Refrigerant charging must be carried out in accordance with CAN/CSA B52
- Ensure that the HVAC system has the proper refrigerant charge.
- Improper charging will lower the life expectancy, efficiency, and capacity of the unit.
- Verify proper refrigerant charge - Superheat, subcooling and other methods approved by OEM
- Compare subcooling/superheat measurement results with OEM data to evaluate refrigerant charge.

Weigh-In Charge

- Can/should be performed year-round**

Liquid Line Set Diameter	Oz. per 5 ft. (grams per 1.5 m) adjust from 15ft. (4.5 m) line set*
3/8 in. (10 mm)	3 ounces per 5 feet (85g per 1.5 m)

*If line length is greater than 15 ft. (4.5 m), add this amount.
If line length is less than 15 ft. (4.5 m), subtract this amount.

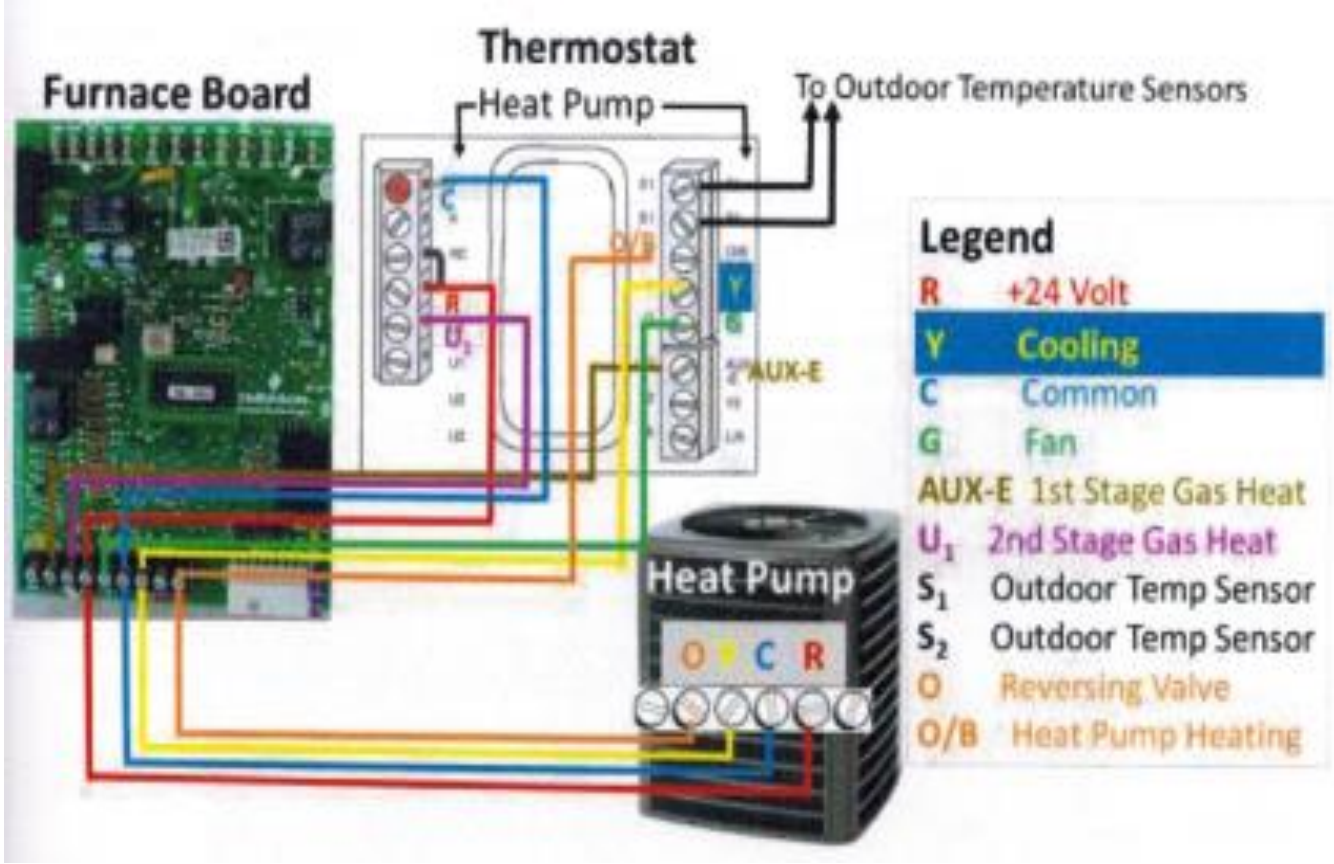
**Check OEM specifications for factory charge data and instructions.

Ducting Considerations

- Duct system design must follow NBC (Section 9.33.6) and the TECA Forced Air Guideline, HRAI Residential Air System Design manual (SAR-R2), or ACCA Manual D
- Always ensure that any existing ductwork is adequately sized for the heat pump airflow requirements and available static pressure
- Ducts systems should be designed to minimize friction losses
- Pay close attention to available static pressure, especially with mini-ducted air handlers
- New supply and return ducts must be sealed with suitable long-life material to minimize air leakage
- Avoid ducts in unconditioned spaces when possible
- Use rigid ducting when possible

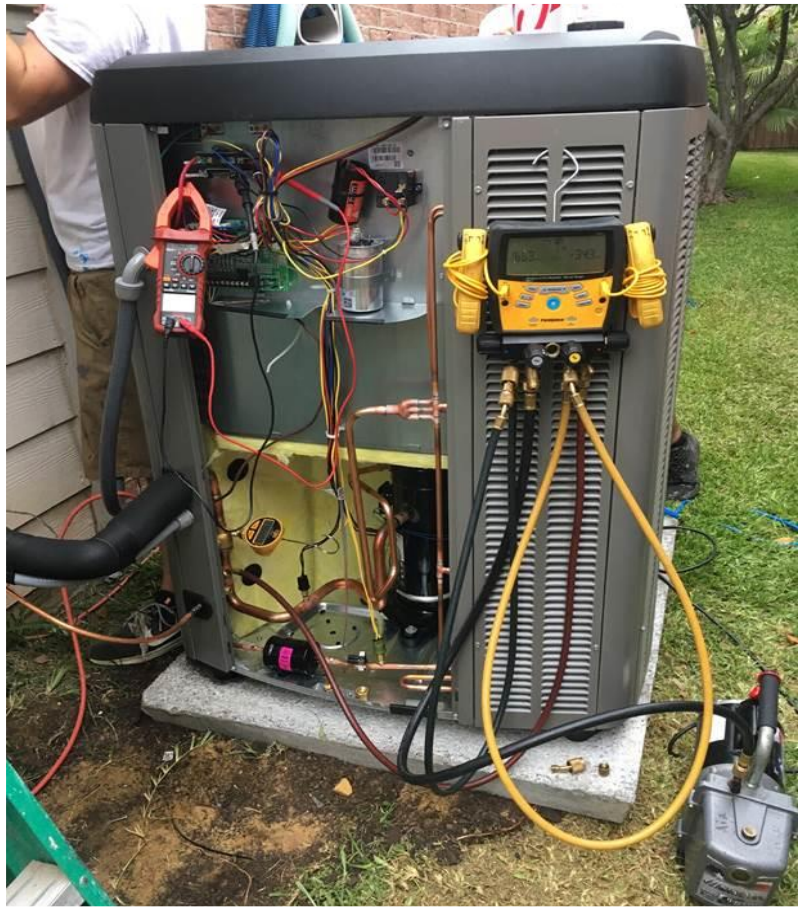
System Controls

- Contractors should ensure proper selection and functioning of system controls
- **Operating controls:**
  - Thermostats, humidistats, economizer controls, hydronic outdoor reset controls, etc.
- **Safety controls:**
  - Temperature limit switch, airflow switch, condensate overflow switch, etc.



Commissioning: Benefits

- Improved project execution
- Ensure that the system meets the homeowner's requirements
- Optimized energy usage
- Corrective actions are completed by contractor at the project completion
- The number of contractor call backs is significantly reduced
  - Ensure warranty is maintained
  - Ensure equipment longevity
- Show due diligence in a court of law



Commissioning

- Testing and commissioning must comply with the Section 6.3 of CSA Standard C273.5-11
- Confirm that all control settings are done as per manufacturer's specifications taking the economic cut-off and thermal balance point setting into consideration
- Check all control and electrical wiring connections before starting the system
- Clean all ductwork (where requested by homeowners), accessories, and existing air handlers and install a clean filter as per design before start-up

Commissioning (cont'd…)

At a minimum, the following operational checks and measurements should be completed:

- **Airflow:** The airflow across indoor coils shall be as per manufacturer's specifications.
- **Refrigerant charge:** Refrigerant charge evaluation relies on measurement of operating pressures and comparison to pressures specified by the manufacturer.
- **Power inputs:** Power inputs of the circulating fan motor and compressor motor should be as per manufacturer's specification.
- **Performance:** Calculate actual BTU/h performance

Homeowner Education and Maintenance: Contractor Benefits

- Contractors must educate the homeowner on both proper operation and maintenance of the HVAC equipment.
  - This benefits both homeowners and contractors
  - Educated homeowner/operator means efficient operation of the equipment and satisfied customer
  - Helps customers to differentiate between bad and good contractors
  - Leads to long term maintenance contracts
  - Improved relationship with homeowners, which leads to more business referrals

Homeowner Education and Maintenance

- Homeowner's understanding of how to operate and maintain the new system is the biggest factors in their satisfaction.
- Contractors should provide and/or educate homeowners on the following items:
  - Original equipment manufacturer (OEM) equipment performance information and Owner's Manual
  - Model and serial numbers of all equipment
  - Proper operation of the system, including operation and programming of the indoor temperature controller (i.e. thermostat)
  - Explanation of the proper service and maintenance requirements

Homeowner Education and Maintenance (cont'd…)

- A discussion of other common maintenance concerns
- Warranty coverage of the ASHP system and control system including servicing requirements for compliance with warranty policy
- Copy of installation record and commissioning checklist
- Proper labeling of switches
- Information on heat pump heating characteristics

Discussion Questions

- What is the most common issue you run into with installing heat pumps in existing homes?
- What are the most common reasons for call backs on heat pumps?

Common Challenges and Solutions

Challenges	Solutions
New system sized based on the size of the old unit, some “rule of thumb” or up-sized ‘just in case’.	Perform a comprehensive **load calculation** to determine what the home needs and select equipment accordingly.
Undersized ductwork **– existing ductwork in a retrofit application that was either not initially sized correctly or can’t handle the airflow requirements of the new system.**	Check existing system’s static pressure to diagnose problems ahead of time. Perform a duct design calculation to determine what is required and **develop a scope of work to include duct repair or renovation.**
Proper clearance around heat pumps – **Newer higher SEER units are typically bigger than older units. The older unit’s location may not afford proper space or clearances.**	Locate/relocate new unit to **ensure proper clearances.**

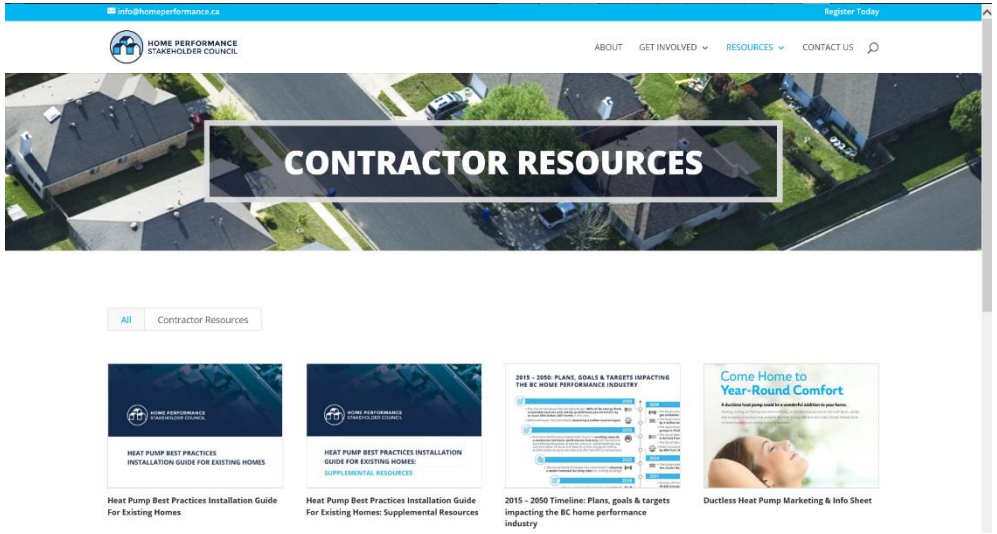
Common Challenges and Solutions (cont'd…)

Challenges	Solutions
Turning the system on and walking away assuming everything is ok, and the customer will call if there's a problem.	A **commissioning procedure** should be conducted and recorded to verify the equipment is operating as designed.
System making unusual noises – **Heat pumps operate differently than straight cooling units.**	**Homeowner education** – homeowners should be told what to expect as normal sounds such as during the defrost cycle, long running cycles in heating, steam coming off the unit and so on. Alert them regarding abnormal sounds and conditions and when to call for service.

Section 5: Conclusions and Q&A

Conclusions

- Seeking to maximize the energy savings and GHG emissions reductions associated with heat pumps by increasing the quality of sizing, installation, and commissioning
- High-level overview of contents of Guide and Supplemental Resources
- Contractor resource documents for heat pump installations available here:
  - http://homeperformance.ca/contractor-resources/
  - https://betterhomesbc.ca/contractor-support/
- May be referenced by residential retrofit EE programs in BC in near future



Q&A

Section 6: Rebates for Heat Pump Installation

THIS SECTION PROVIDES AN OVERVIEW OF AVAILABLE REBATE PROGRAMS IN BC FOR HEAT PUMP INSTALLATIONS AND HOW TO PARTICIPATE IN THEM TO BETTER SERVE YOUR CUSTOMERS.

Heat Pump Rebates – BC Hydro
(Electric to Electric)

Effective April 1, 2019

Qualifying system	Requirements	Rebate
Mini-split single head	• HSPF ≥10.0, SEER ≥18 • Variable speed compressor required	$1,000
Mini-split multi-head	• HSPF ≥9.30, SEER ≥16 • Variable speed compressor required	$1,000
Central heat pumps	• HSPF ≥9.30, SEER≥16 • Variable speed compressor required	$2,000

Heat Pump Rebates – FortisBC Electric (Electric to Electric)

Effective April 1, 2019

Qualifying system	Requirements	Rebate
Mini-split single head	• HSPF ≥10.0, SEER ≥18 • Variable speed compressor required	$1,200
Mini-split multi-head	• HSPF ≥9.30, SEER ≥16 • Variable speed compressor required	$2,000
Central heat pumps	• HSPF ≥8.50, SEER≥15	$1,200
	• HSPF ≥9.30, SEER≥16 • Variable speed compressor required	$2,000

Heat Pump Rebates - CleanBC Better Homes
(Convert to Electric)

Effective April 1, 2019

Qualifying system	Requirements	Rebate
Mini-split *(single and multi-head)*	• HSPF ≥9.30, SEER ≥16 • Variable speed compressor required	$3,000
Central heat pumps	• HSPF ≥8.50, SEER≥15	$1,200
	• HSPF ≥9.30, SEER≥16 • Variable speed compressor required	$3,000

Municipal Top-Up Rebates

- No additional application required
- Eligibility is automatically assessed with the submitted CleanBC Better Homes and Home Renovation Rebate application for the applicable rebates

- For further information on municipal top-ups: https://betterhomesbc.ca/municipal-offers/

- For details on available rebates, eligibility requirements, application process, FAQs, etc.: https://betterhomesbc.ca/rebates/cleanbc-better-homes-and-home-renovation-rebate-programs/

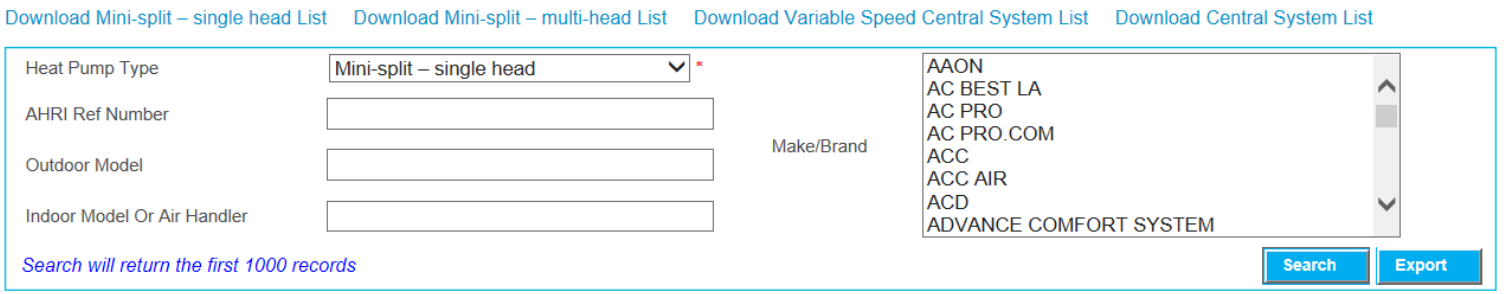
Eligible Mini Splits and Multi Splits

Eligible systems are listed on the Heat Pump Qualifying List available at: www.bchydro.com/qualifyingheatpumps

Search divided into 2 types:

- Mini-Split Single Head
- Mini-Split Multi Head
- Variable Speed Central Heat Pump
- Central Heat Pump

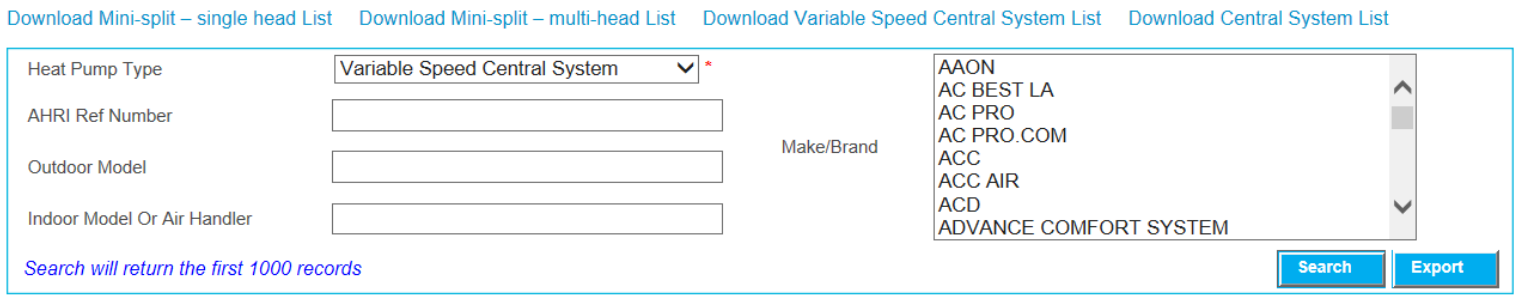
Downloadable lists also available



AHRI Ref Number	Heat Pump Type	Make	Outdoor Model	Indoor Model or Air Handler	SEER rating	HSPF rating	Additional Rebate Eligibility Notes
5620402	Mini-split – single head	AIR-CON	A18CI4H4R18	A18EM4H4R18	18.00	10.00	
5620403	Mini-split – single head	AIR-CON	A18CI4H4R24	A18EM4H4R24	18.00	10.00	
7826813	Mini-split – single head	AIR-CON	ASKCI4H4R18	ASKEL4H4R18	17.00	9.50	Only available for customers converting to electric from a fossil fuel
7826816	Mini-split – single head	AIR-CON	ASKCI4H4R24	ASKEC4H4R24	18.00	10.00	
7826817	Mini-split – single head	AIR-CON	ASKCI4H4R24	ASKEL4H4R24	16.00	10.00	Only available for customers converting to electric from a fossil fuel
8935243	Mini-split – single head	AMERICAN STANDARD	4TXK2212AL0N0**	4MXW2212AL0N0**	20.00	9.60	Only available for customers converting to electric from a fossil fuel
7151530	Mini-split – single head	AMERICAN STANDARD	4TXK2709A10N0AA	4MXW2709A10N0AA	27.00	10.00	
7151532	Mini-split – single head	AMERICAN STANDARD	4TXK2712A10N0AA	4MXW2712A10N0AA	25.00	10.00	
7151534	Mini-split – single head	AMERICAN STANDARD	4TXK2718A10N0AA	4MXW2718A10N0AA	21.00	10.00	

Eligible Central Systems

Eligible systems are listed on the Heat Pump Qualifying List available at: www.bchydro.com/qualifyingheatpumps



AHRI Ref Number	Heat Pump Type	Make	Outdoor Model	Indoor Model or Air Handler	SEER rating	HSPF rating	Additional Rebate Eligibility Notes
8104492	Variable Speed Central System	DAIKIN	2MXS18NMVJU	Mixed Ducted and Non-Ducted Indoor Units	16.45	9.45	
9038998	Variable Speed Central System	DAIKIN	RXTQ48TAVJU	FXMQ_PBVJU	17.00	9.50	
9010097	Variable Speed Central System	DAIKIN	RXTQ60TAVJU	FXMQ_PBVJU	16.00	10.50	
9038999	Variable Speed Central System	DAIKIN	RXTQ60TAVJU	FXMQ_PBVJU	17.00	10.50	
5039475	Variable Speed Central System	DAIKIN	RZQ18PVJU9	FBQ18PVJU	17.50	10.60	
5376729	Variable Speed Central System	DAIKIN	RZQ18PVJU9	FTQ18PBVJU	20.00	12.00	
5039476	Variable Speed Central System	DAIKIN	RZQ24PVJU9	FBQ24PVJU	16.50	10.50	
5376730	Variable Speed Central System	DAIKIN	RZQ24PVJU9	FTQ24PBVJU	19.00	11.50	
5376731	Variable Speed Central System	DAIKIN	RZQ30PVJU9	FTQ30PBVJU	19.50	10.00	
5376733	Variable Speed Central System	DAIKIN	RZQ36PVJU9	FTQ36PBVJU	18.00	9.50	
8915233	Variable Speed Central System	FRIEDRICH	MR24DY3JMA	MD**Y3j	17.50	9.80	

Contractor Incentive Program

- $50 per unit contractor incentive available if:
  - Heat pump is installed and replaces a fossil fuel (oil, natural gas or propane) heating system
  - Mini-split, multi-split and central ducted systems qualify
- Monthly payments will be made by cheque to the company
- Municipal contractor incentive top-ups available:
  - City of Vancouver: $300
  - City of North Vancouver: $50
  - Municipality of Whistler: $50
  - District of Saanich: $50

How to Apply

- Read the program Terms and Conditions to confirm eligibility
- Complete the online application form
- Must be submitted within 6 months of upgrade installation
- Upload copies of all required supporting documentation including invoices
  - www.bchydro.com/homerebates
  - www.fortisbc.com/homerebates
  - www.betterhomesbc.ca

More Information and Support

Home Renovation Rebate:

- BC Hydro: Tony Ceh, Anthony.Ceh@bchydro.com
- FortisBC: Erica Gugay, Erica.Gugay@fortisbc.com

CleanBC Better Homes:

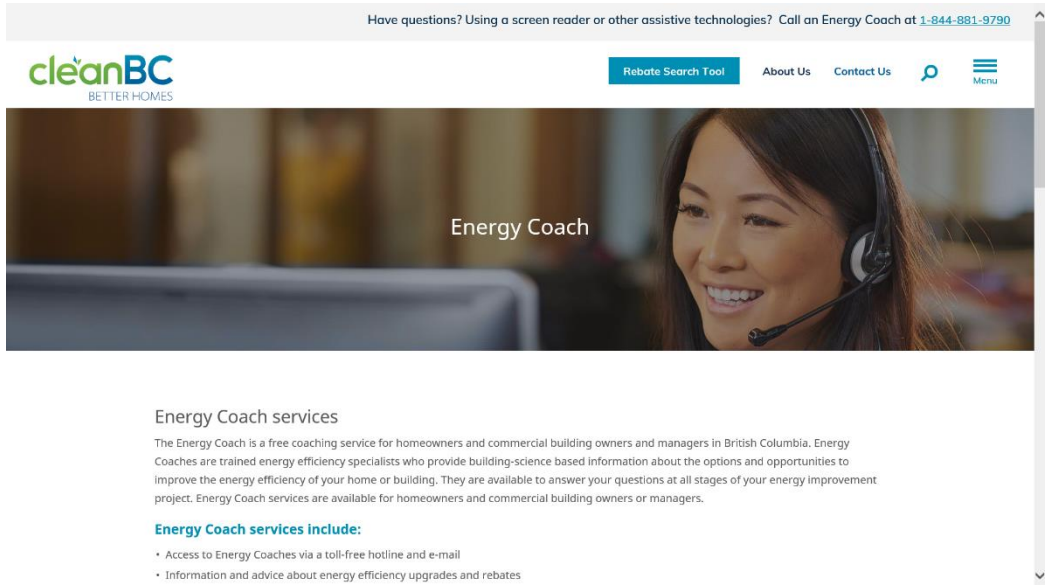
- Ministry of Energy, Mines, and Petroleum Resources: betterhomesbc@gov.bc.ca

Customer Support:

- BetterHomesBC Energy Coach: 1-844-881-9790
- BC Hydro: 1-800-224-9376
- FortisBC (gas): homerebates@fortisbc.com
- FortisBC (electricity): homerebates@fortisbc.com

Websites:

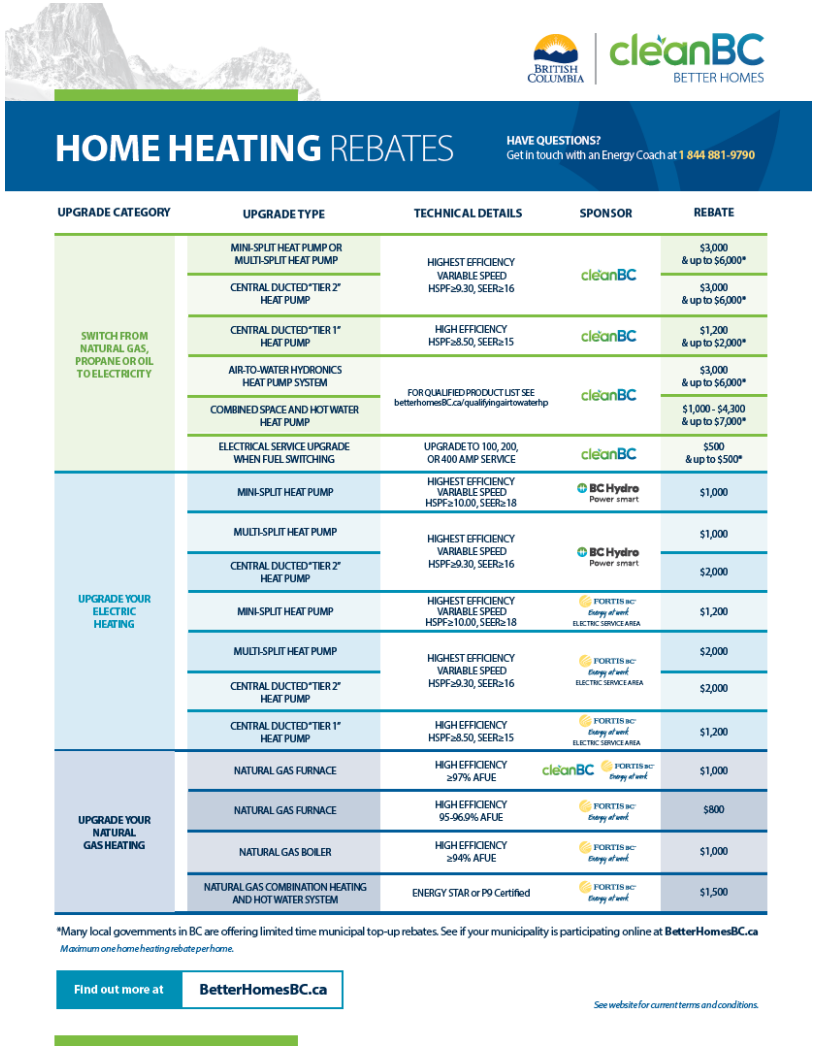
- BetterHomesBC: www.betterhomesbc.ca
- BC Hydro: www.bchydro.com/homerebates
- FortisBC: www.fortisbc.com/homerebates



Rebate Overview

Rebates and Incentives

- Download the **Better Homes BC Rebate Chart** for an at a glance guide to current rebates and offerings:
  https://betterhomesbc.ca/better-homes-bc-rebate-chart/



BRITISH COLUMBIA | cleanBC BETTER HOMES

HOME HEATING REBATES

HAVE QUESTIONS? Get in touch with an Energy Coach at 1 844 881-9790

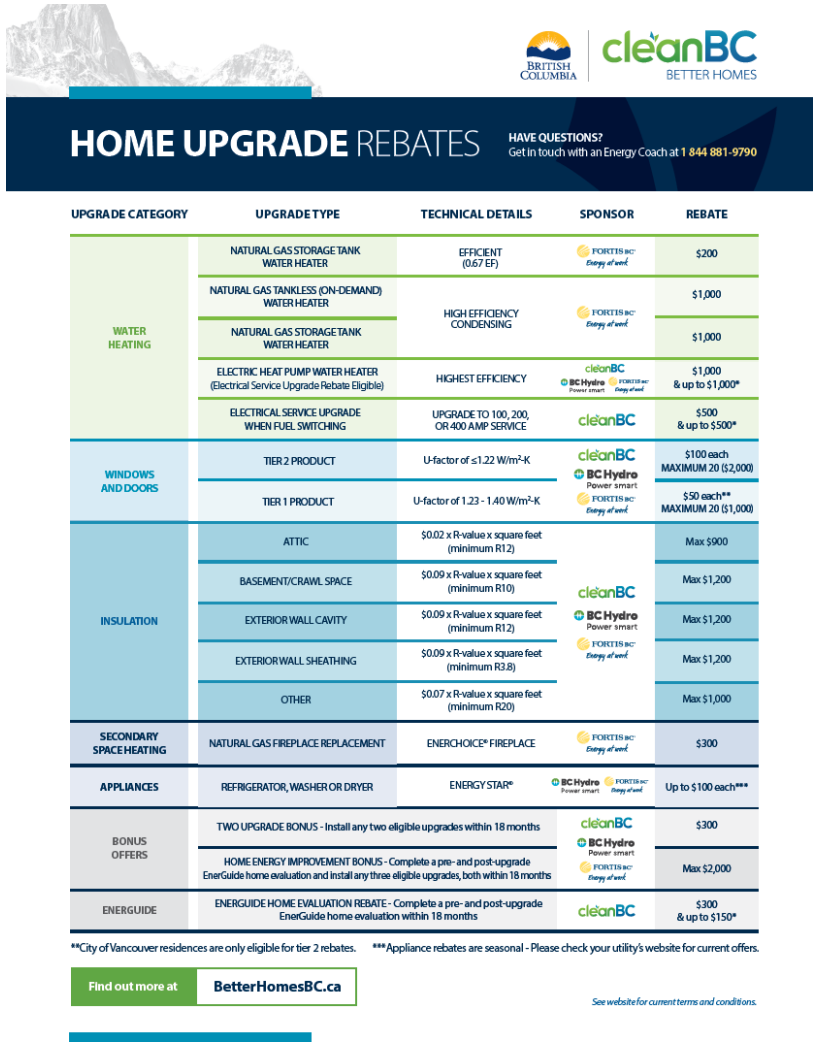
UPGRADE CATEGORY	UPGRADE TYPE	TECHNICAL DETAILS	SPONSOR	REBATE
SWITCH FROM NATURAL GAS, PROPANE OR OIL TO ELECTRICITY	MINI-SPLIT HEAT PUMP OR MULTI-SPLIT HEAT PUMP	HIGHEST EFFICIENCY VARIABLE SPEED HSPF≥9.30, SEER≥16	cleanBC	$3,000 & up to $6,000*
	CENTRAL DUCTED "TIER 2" HEAT PUMP			$3,000 & up to $6,000*
	CENTRAL DUCTED "TIER 1" HEAT PUMP	HIGH EFFICIENCY HSPF≥8.50, SEER≥15	cleanBC	$1,200 & up to $2,000*
	AIR-TO-WATER HYDRONICS HEAT PUMP SYSTEM	FOR QUALIFIED PRODUCT LIST SEE betterhomesBC.ca/qualifyingairtowaterhp	cleanBC	$3,000 & up to $6,000*
	COMBINED SPACE AND HOT WATER HEAT PUMP			$1,000 - $4,300 & up to $7,000*
	ELECTRICAL SERVICE UPGRADE WHEN FUEL SWITCHING	UPGRADE TO 100, 200, OR 400 AMP SERVICE	cleanBC	$500 & up to $500*
UPGRADE YOUR ELECTRIC HEATING	MINI-SPLIT HEAT PUMP	HIGHEST EFFICIENCY VARIABLE SPEED HSPF≥10.00, SEER≥18	BC Hydro Power smart	$1,000
	MULTI-SPLIT HEAT PUMP	HIGHEST EFFICIENCY VARIABLE SPEED HSPF≥9.30, SEER≥16	BC Hydro Power smart	$1,000
	CENTRAL DUCTED "TIER 2" HEAT PUMP			$2,000
	MINI-SPLIT HEAT PUMP	HIGHEST EFFICIENCY VARIABLE SPEED HSPF≥10.00, SEER≥18	FORTIS BC Energy at work ELECTRIC SERVICE AREA	$1,200
	MULTI-SPLIT HEAT PUMP	HIGHEST EFFICIENCY VARIABLE SPEED HSPF≥9.30, SEER≥16	FORTIS BC Energy at work ELECTRIC SERVICE AREA	$2,000
	CENTRAL DUCTED "TIER 2" HEAT PUMP			$2,000
	CENTRAL DUCTED "TIER 1" HEAT PUMP	HIGH EFFICIENCY HSPF≥8.50, SEER≥15	FORTIS BC Energy at work ELECTRIC SERVICE AREA	$1,200
UPGRADE YOUR NATURAL GAS HEATING	NATURAL GAS FURNACE	HIGH EFFICIENCY ≥97% AFUE	cleanBC FORTIS BC Energy at work	$1,000
	NATURAL GAS FURNACE	HIGH EFFICIENCY 95-96.9% AFUE	FORTIS BC Energy at work	$800
	NATURAL GAS BOILER	HIGH EFFICIENCY ≥94% AFUE	FORTIS BC Energy at work	$1,000
	NATURAL GAS COMBINATION HEATING AND HOT WATER SYSTEM	ENERGY STAR or P9 Certified	FORTIS BC Energy at work	$1,500

*Many local governments in BC are offering limited time municipal top-up rebates. See if your municipality is participating online at **BetterHomesBC.ca**

Maximum one home heating rebate per home.

Find out more at BetterHomesBC.ca

See website for current terms and conditions.



BRITISH COLUMBIA | cleanBC BETTER HOMES

HOME UPGRADE REBATES

HAVE QUESTIONS? Get in touch with an Energy Coach at 1 844 881-9790

UPGRADE CATEGORY	UPGRADE TYPE	TECHNICAL DETAILS	SPONSOR	REBATE
WATER HEATING	NATURAL GAS STORAGE TANK WATER HEATER	EFFICIENT (0.67 EF)	FORTIS BC Energy at work	$200
	NATURAL GAS TANKLESS (ON-DEMAND) WATER HEATER	HIGH EFFICIENCY CONDENSING	FORTIS BC Energy at work	$1,000
	NATURAL GAS STORAGE TANK WATER HEATER			$1,000
	ELECTRIC HEAT PUMP WATER HEATER (Electrical Service Upgrade Rebate Eligible)	HIGHEST EFFICIENCY	cleanBC BC Hydro Power smart FORTIS BC Energy at work	$1,000 & up to $1,000*
	ELECTRICAL SERVICE UPGRADE WHEN FUEL SWITCHING	UPGRADE TO 100, 200, OR 400 AMP SERVICE	cleanBC	$500 & up to $500*
WINDOWS AND DOORS	TIER 2 PRODUCT	U-factor of ≤1.22 W/m²-K	cleanBC BC Hydro Power smart FORTIS BC Energy at work	$100 each MAXIMUM 20 ($2,000)
	TIER 1 PRODUCT	U-factor of 1.23 - 1.40 W/m²-K		$50 each** MAXIMUM 20 ($1,000)
INSULATION	ATTIC	$0.02 x R-value x square feet (minimum R12)	cleanBC BC Hydro Power smart FORTIS BC Energy at work	Max $900
	BASEMENT/CRAWL SPACE	$0.09 x R-value x square feet (minimum R10)		Max $1,200
	EXTERIOR WALL CAVITY	$0.09 x R-value x square feet (minimum R12)		Max $1,200
	EXTERIOR WALL SHEATHING	$0.09 x R-value x square feet (minimum R3.8)		Max $1,200
	OTHER	$0.07 x R-value x square feet (minimum R20)		Max $1,000
SECONDARY SPACE HEATING	NATURAL GAS FIREPLACE REPLACEMENT	ENERCHOICE® FIREPLACE	FORTIS BC Energy at work	$300
APPLIANCES	REFRIGERATOR, WASHER OR DRYER	ENERGY STAR®	BC Hydro Power smart FORTIS BC Energy at work	Up to $100 each***
BONUS OFFERS	TWO UPGRADE BONUS - Install any two eligible upgrades within 18 months		cleanBC BC Hydro Power smart FORTIS BC Energy at work	$300
	HOME ENERGY IMPROVEMENT BONUS - Complete a pre- and post-upgrade EnerGuide home evaluation and install any three eligible upgrades, both within 18 months			Max $2,000
ENERGUIDE	ENERGUIDE HOME EVALUATION REBATE - Complete a pre- and post-upgrade EnerGuide home evaluation within 18 months		cleanBC	$300 & up to $150*

**City of Vancouver residences are only eligible for tier 2 rebates. ***Appliance rebates are seasonal - Please check your utility's website for current offers.

Find out more at BetterHomesBC.ca

See website for current terms and conditions.

HOME PERFORMANCE STAKEHOLDER COUNCIL

Thank You!